AUTOMATION OF 6 WHEELS ROBOT (HOBO L3A1 ROBOT)

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ABSTRACT

The project is about to design a system which enables the 6 wheel robots named HOBO L3A1 ATM automated. A joystick acts an input to the system which embedded on board by interfacing with microcontroller and must be programmed according to expected result to make the robot in functions. The motor speed direction is controlled by developing H-bridge circuits which interface with microcontroller. The robot consists of 6 wheels of different motors that controlled the robot wheels. The overall robot chassis had finished which was designed with motor controls that driven by independent motor, thus the HOBO ATM robot conveniently switch its locomotion modes according to the operational. This project should be done in accordance with planning requirements. A microcontroller Arduino AtMega1280/2560 was needed in order to achieve the objectives of the project. An appropriate command need to transfer to the microcontroller. The embedded control system is not done yet, so a control system needs to be established to make the robot automated and functioned as well. The method for this project is designing a schematic diagram of circuit then implemented onto board. The microcontroller was programmed according to desired output. At the end of project, it was expected that the robot wheels can automate after the joystick (input) is controlled.

ABSTRAK

Projek ini adalah untuk mereka bentuk satu sistem yang membolehkan robot beroda enam yang bernama HOBO L3A1 berfungsi. Pedal diperlukan sebagai input untuk menggerakkan robot tersebut. Dengan menggunakan mikropengawal yang diprogramkan untuk menjadikan robot berfungsi. Robot yang terdiri daripada 6 roda dikawal oleh motor yang berlainan . Struktur robot keseluruhan telah lengkap yang direka bentuk kawalan motor yang setiap satunya mempunyai motor masing-masing , oleh itu, robot ini mudah bertukar mod gerak alih mengikut operasi. Projek ini perlu dilakukan mengikut perancangan yang telah ditetapkan. Sebuah mikropengawal Arduino AtMega1280 diperlukan untuk membuat ia berfungsi dengan baik. Suatu perintah yang sesuai perlu untuk diprogramkan kepada mikropengawal. Sistem kawalan dalaman tidak dilakukan lagi , maka satu sistem kawalan yang diperbaharui perlu ditubuhkan untuk membuat fungsi robot dan bergerak ke hadapan. Kaedah untuk projek ini adalah mereka bentuk gambar rajah skematik litar yang kemudian dilaksanakan ke board.Mikropengawal yang diprogramkan mengikut output yang dikehendaki. Pada akhir projek, ia adalah dijangka bahawa roda robot boleh bergerak selepas pedal (input) dikawal.

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LIST OF ABBREVIATIONS

V	Volt
DC	Direct Current
MHz	Mega Hertz
USB	Universal Serial Bus
cc	Clock Cycle
GND	Ground
Vcc	5V DC
LED	Light Emitting Diode
PCB	Printed Circuit Board
DAC	Digital to Analog Converter
BJT	Bipolar Junction Transistor
MOSFET	Metal Oxide Semiconductor Field-effect Transistor
PWM	Pulse Width Modulation
ATM	Angkatan Tentera Malaysia
USU	Utah State University
ODV	Omni Directional Vehicles
Hz	Hertz
CPU	Central Processing Unit

MSB	Most Significant Bit
LSB	Least Significant Bit
B	Base
E	Emitter
C	Collector
S	Source
G	Gate
D	Drain

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1Background

The project was implemented in collaboration UMP-ATM. This collaboration is to develop research in microcontroller and motor driver interfacing theory and practical. UMP had received a bomb diffusion robot named HOBO ATM robot from Angkatan Tentera Malaysia (ATM). We just receive the robot complete in its frame but cannot move or in other words not fully functioning. Where as, for the ATM they need to use the robot which can be used in military actions when it is functioned, so the robot was hand up to UMP so that we can turn the robot into functioning according to our expert in designing its input hardware and programming which enable the robot to move based on desired output. As for UMP, we cannot afford to build the robot frame according to high expensed, so we are using our knowledge and the ATM using their expenses. The HOBO ATM robot was build at 1997.

The Hobo is used mainly in applications of firefighting, the nuclear industry, airfield damage repair, terrorist or hostage situations, and the removal of debris and toxic chemicals, or in any situation or environment which is hazardous to human life. Hobo is built to exacting military standards and specifications and is currently in use in over 22 countries and with 34 agencies, including the United Nations. Combat proven, Hobo has earned its reputation for being a tough, versatile and reliable vehicle from its years of operational experience in all extremes of climate and terrain. Hobo's exceptional performance is mainly due to its wheeled configuration. Six wheels, each independently driven, give the Hobo the ability to maneuver through the roughest terrain, through mud and sand, snow and water. Operational under radio control, it has a minimum range of 1 km line of sight. [5]

The automation of robot needs 2 major elements that need to be implemented in order to make the robot function. Firstly is microcontroller for programming and second is DC motor for the robot movement. This project is about interfacing DC motor and microcontroller. By using DC motor , the speed of motor can be controlled. Usually H-bridge is preferred way of interfacing a DC motor with a microcontroller. According to the H-bridge theory, the motion of the motor can be controlled. When there is a need for controlling the speed of a DC motor in an efficient manner, pulse width modulation (PWM) is generated. The duty cycle of PWM can be varied linearly through the current applied to the joystick as input hardware. For example, when 50 % of duty cycle is applied, so the speed of motor is 50 % from its actual speed that has been applied, this will affect the robot motion. Below is the hobo robot picture that consist of 6 wheel and each wheels has independently motor driver that stored in the robot body.

Figure 1.1: Hobo L3A1 Robot

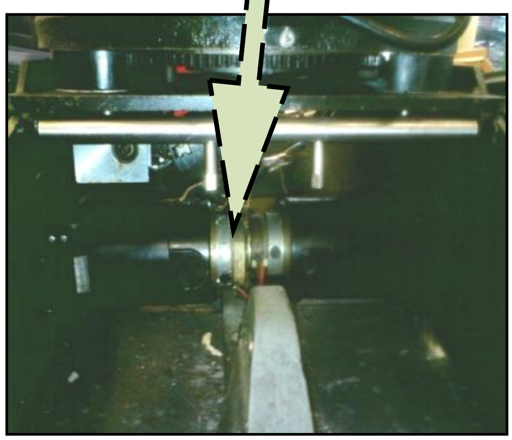

Figure 1.2: Motor driver and HOBO Robot

1.2 Objective of Project

The core objective of this project is to explore about microcontroller and DC motor interfacing in system design to establish hardware (joystick as the input) and make programming which enables the HOBO L3A1 ATM robot move based on pulse width modulation concept by using DC motor and microcontroller of Arduino AtMega1280. The system and the programming will be able to control the motor speed which enables the robot to move according the desired motion when joystick is applied.

1.3 Scope of Project

The scope of this project is as follow;

i. To choose the suitable microcontroller type for robot automation.

ii. To choose the appropriate components to fulfill DC motor specifications in designing H-bridge circuit.

iii. The DC motor will be as output that generates the mechanical energy based on pulse width modulation (PWM) varying from electrical energy in microcontroller.

iv. To describe how the microcontroller can be interface with DC motor in operating the robot automation

1.4 Problem Statement

The HOBO L3A1 robot is consist of six wheels, each wheels is driven by independent dc motor. The robot is not fully functioning and cannot be moved, therefore we need to implement the microcontroller to be interfaced with DC Motor of the robot in the hardware design as well as to develop programming code to the microcontroller and then design a complete system to all six DC motors which enabled the robot to move when input is applied to the system.

1.5 Thesis Outline

This thesis consists five chapters. In first chapter, it discusses about introduction and overview about this project includes background, objectives, and scope and problem statements of the projects.

Chapter two is explanations about literature review as study material, researches and references. The topics that I have studied are about the other method of speed control to compare and analysis their advantages and disadvantages. Furthermore, I can explore about the different types of transistors and other components that meet the requirements with my project specifications. From the literature review, knowledge can be gained thus implement in this project.

The methodology that I have done are discusses on chapter three. This is explanations about the method used to complete hardware and software.

Chapter four are discusses of the result and analysis of this project. This chapter explains the result obtained regarding the performance of the system.

For the last chapter are describes conclusion and future recommendation to make this project greatly. This thesis included with references and appendices. We can refer the further information about this project in references which is states the source and their authors. Datasheets of the components, photos and other information were placed on the appendices part.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter include the history of robotics and automation, robots for military purposes, microcontroller interfacing with DC motor circuit theory, hardware and software programming.

2.2 Robotics and Automation History

Robots have been developed that can operate like human behaviors and become as a platform to accomplish human commands. Recently there has been increased interest in unmanned ground vehicles robots, especially for use in the military. This platform features consist of multiple "smart wheels" in which each wheel's speed and direction can be independently controlled through dedicated processors. The result is a robot with the ability to completely control both the vehicle's orientation and its motion.

2.2.1 Robots for Military Purpose

Srinivasavaradhan L et al. [2] in the journal title *7TH Sense A Multipurpose Robot for Military, April 2009* said, bomb diffusion can be made in both the automatic and in the user modes. In the automatic mode the robot detects the bomb and diffuses it by disabling the circuitry of the bomb. In case of failure in automatic bomb diffusion the control automatically goes to user mode. Once the user gets the control he can diffuse the bomb from remote location. [2] In the existing system there is only remote monitoring for robots are available. In the system we are going to control the robot from remote location in addition to remote monitoring (for example user mode). Our system also has an automatic mode in which it can take its own decision for combating. We are going to control the robot from remote location by using a computer. Our robot is also capable of detecting and diffusing the bombs more quickly. It can either be done through automatic mode or by user mode.

Kevin L. Moore and Nicholas S. Flann outlined, [3] a series of novel mobile robots based on a specific mobility capability that called as the smart wheel has been developed. For example is a 95-lb ODV vehicle with six smart wheels. Other USU ODV six-wheel vehicles include the ARC III, a 45-lb small-scale robot, and the T2, a 1480-lb robot. The USU smart wheel concept is shown in Fig. 1. Each smart wheel has a drive motor, power and a microcontroller, all in the wheel hub. This is combined with a separate steering motor and with actuation in the *z*-axis to create a three degree-of-freedom mechanism. Infinite rotation in the steering degree of freedom is achieved through an innovative slip ring that allows data and power to pass from the wheel to the chassis without a wired connection.

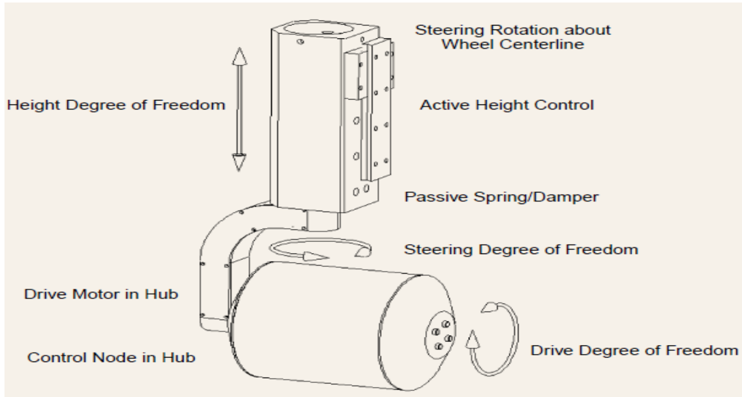

Figure 2.1: The USU smart wheel

The system has three distinct modes of control operation, one of its modes is in the manual control mode; an operator uses a joystick to maneuver the vehicle. A radio modem is used for communication with the joystick. In manual control, commands from the user (movements of the joystick encoded as voltages) are translated into body-referenced motion commands (x, y, θ) by the joystick interpreter [3].

According to Gerald MIES [4] *Military Robots and Industrial Robot* also have a common history. Many developments came out of the military laboratories in the beginning of last century. At this time the governments invest big parts of their budgets in military research and development. The first independent operating systems where used in military applications. Robots in military are still “special machines”, build in small lots and very dedicated for their application. Today industrial robots are mass production machines. The mechanical types, drives, controller, sensors and applications are the key items in their development. Robots in Industry are categorized into four main mechanical robot- types: The linear-type- robot, the scara-type robot, the articulated-type-robot, and, the delta-type-robot. With the progress further development on the servo drives, most robots change their mechanical units into the articulated design. The IFR data’s shows, that the market share of articulated - and delta robots growths fast. Scara robots and linear robot are also using servo motors, but because of their disadvantage in case of degrees of freedom, is the market share of this designs shrinking.

The revolution in the electronic Industry is another indicator for development in robotics. In the eighties, robot became slower if the demand for periphery communication increased, because the capacity of the CPU could not handle motion control and communication. Current generation of robot controllers is based on dual-core architectures. Motion control and data communications are kept separate and processing is distributed over a pair of CPUs. Sensors, for example, let robots see, feel and let robots work safety in there environment.

2.3 Microcontroller Interface with DC Motor

Tom Dickens [1], the kind of motor used is a standard motors with a feedback mechanism to sense its position which offer low cost, easy control, and good power. The control input to a motor tells it to be in a certain position, and logic built into the motor will position it. It has three wires comprised of black for ground, red are the motor's voltage, and white is the control line. The voltage is 5 volts. The control line requires a pulse width modulated (PWM) signal. There are two factors when dealing with a PWM signal: frequency and duty cycle. In this article, Tom Dickens [1] used the S148 type as the servo motor. For the S148, the frequency should be about 33 Hz, or 30 mS in width. True duty cycle is the ratio of high time over total time, for example is about 20%. However, with servos, the length of the high time is what indicates the servo's position. The actual frequency of the signal is not critical. Tests with the S148 indicate that a minimum high-pulse of about 0.1 mS will turn the servo full to the right, while a high-pulse of 2.3 mS will turn it full to the left. A high-pulse of about 1.2 mS will position the servo in the middle of its range. Full left-to-right movement takes about 3/4 of a second. A high-pulse in between these two times will cause the servo to position itself accordingly.